Paper Reference(s)

6690/01

Edexcel GCE

Decision Mathematics D2

Advanced/Advanced Subsidiary

Monday 1 June 2009 – Morning

Time: 1 hour 30 minutes

Materials required for examination
Nil

Items included with question papers
D2 Answer Book

Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions to Candidates

Write your answers for this paper in the D2 answer book provided.
In the boxes on the answer book, write your centre number, candidate number, your surname, initials and signature.
Check that you have the correct question paper.
Answer ALL the questions.
When a calculator is used, the answer should be given to an appropriate degree of accuracy.
Do not return the question paper with the answer book.

Information for Candidates

Full marks may be obtained for answers to ALL questions.
The marks for individual questions and the parts of questions are shown in round brackets: e.g. **(2)**.
There are 8 questions in this question paper. The total mark for this question paper is 75.
There are 8 pages in this question paper. The answer book has 16 pages. Any blank pages are indicated.

Advice to Candidates

You must ensure that your answers to parts of questions are clearly labelled.
You should show sufficient working to make your methods clear to the Examiner.
Answers without working may not gain full credit.

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Write your answers in the D2 answer book for this paper.

1. A company, Kleenitquick, has developed a new stain remover. To promote sales, three salespersons, Jess, Matt and Rachel, will be assigned to three of four department stores 1, 2, 3 and 4, to demonstrate the stain remover. Each salesperson can only be assigned to one department store.

The table below shows the cost, in pounds, of assigning each salesperson to each department store.

	1	**2**	**3**	**4**
Jess	15	11	14	12
Matt	13	8	17	13
Rachel	14	9	13	15

(a) Explain why a dummy row needs to be added to the table.

(1)

(b) Complete Table 1 in the answer book.

(1)

(c) Reducing rows first, use the Hungarian algorithm to obtain an allocation that minimises the cost of assigning salespersons to department stores. You must make your method clear and show the table after each iteration.

(6)

(d) Find the minimum cost.

(1)

(Total 9 marks)

2. (a) Explain the difference between the classical and the practical travelling salesperson problems.

(2)

The table below shows the distances, in km, between six data collection points, A, B, C, D, E, and F.

	A	**B**	**C**	**D**	**E**	**F**
A	-	77	34	56	67	21
B	77	-	58	58	36	74
C	34	58	-	73	70	42
D	56	58	73	-	68	38
E	67	36	70	68	-	71
F	21	74	42	38	71	-

Rachel must visit each collection point. She will start and finish at A and wishes to minimise the total distance travelled.

(b) Starting at A, use the nearest neighbour algorithm to obtain an upper bound. Make your method clear.

(3)

Starting at B, a second upper bound of 293 km was found.

(c) State the better upper bound of these two, giving a reason for your answer.

(1)

By deleting A, a lower bound was found to be 245 km.

(d) By deleting B, find a second lower bound. Make your method clear.

(4)

(e) State the better lower bound of these two, giving a reason for your answer.

(1)

(f) Taking your answers to (c) and (e), use inequalities to write down an interval that must contain the length of Rachel's optimal route.

(1)

(Total 12 marks)

3. A two-person zero-sum game is represented by the following pay-off matrix for player A.

	B plays 1	B plays 2	B plays 3
A plays 1	–5	6	–3
A plays 2	1	–4	13
A plays 3	–2	3	–1

(a) Verify that there is no stable solution to this game.

(3)

(b) Reduce the game so that player B has a choice of only two actions.

(1)

(c) Write down the reduced pay-off matrix **for player B**.

(2)

(d) Find the best strategy for player B and the value of the game to player B.

(7)

(Total 13 marks)

4.

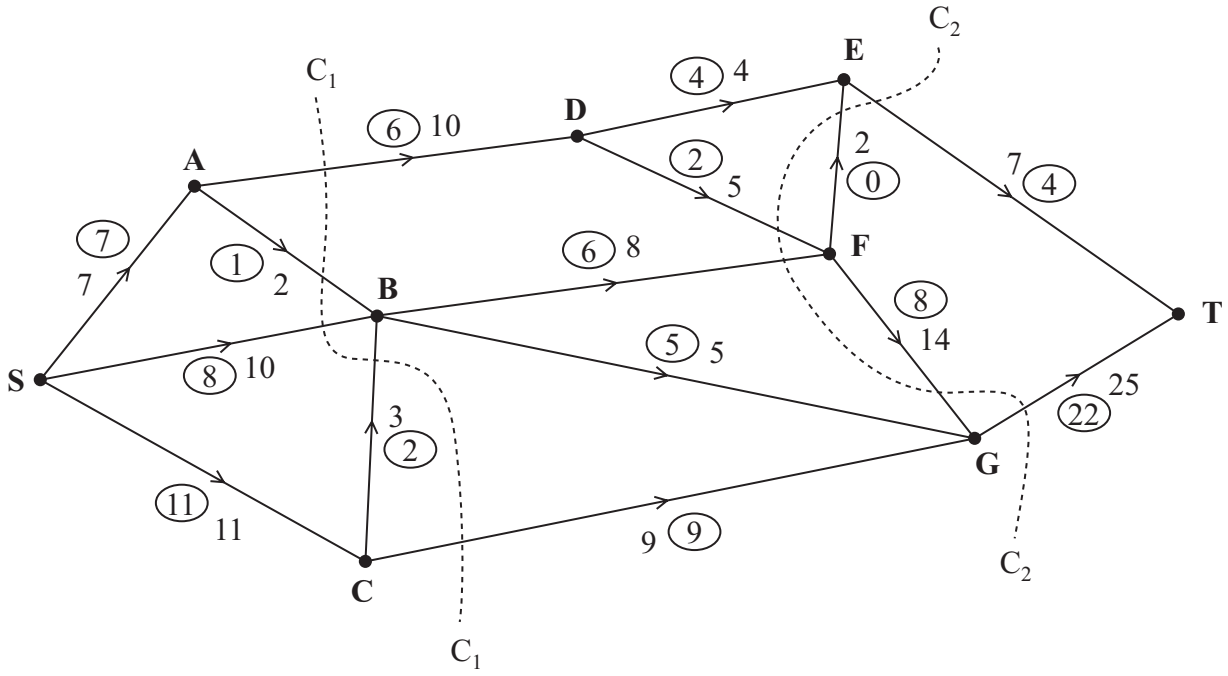


Figure 1

Figure 1 shows a capacitated network. The capacity of each arc is shown on the arc. The numbers in circles represent an initial flow from S to T.

Two cuts C_1 and C_2 are shown in Figure 1.

(a) Find the capacity of each of the two cuts.

(2)

(b) Find the maximum flow through the network. You must list each flow-augmenting route you use together with its flow.

(3)

(Total 5 marks)

5. While solving a maximising linear programming problem, the following tableau was obtained.

Basic Variable	x	y	z	r	s	t	value
z	$\frac{1}{4}$	$-\frac{1}{4}$	1	$\frac{1}{4}$	0	0	2
s	$\frac{5}{4}$	$\frac{7}{4}$	0	$-\frac{3}{4}$	1	0	4
t	3	$\frac{5}{2}$	0	$-\frac{1}{2}$	0	1	2
P	-2	-4	0	$\frac{5}{4}$	0	0	10

(a) Write down the values of x, y and z as indicated by this tableau.

(2)

(b) Write down the profit equation from the tableau.

(2)

(Total 4 marks)

6. The table below shows the cost, in pounds, of transporting one unit of stock from each of three supply points, X, Y and Z to three demand points, A, B and C. It also shows the stock held at each supply point and the stock required at each demand point.

	A	**B**	**C**	Supply
X	17	8	7	22
Y	16	12	15	17
Z	6	10	9	15
Demand	16	15	23	

(a) This is a **balanced problem**. Explain what this means.

(1)

(b) Use the north west corner method to obtain a possible solution.

(1)

(c) Taking ZA as the entering cell, use the stepping-stone method to find an improved solution. Make your route clear and state your exiting cell.

(3)

(d) Perform one more iteration of the stepping-stone method to find a further improved solution. You must make your shadow costs, improvement indices, entering cell, exiting cell and route clear.

(6)

(e) State the cost of the solution you found in part (d).

(1)

(Total 12 marks)

7. Minty has £250 000 to allocate to three investment schemes. She will allocate the money to these schemes in units of £50 000. The net income generated by each scheme, in £1000s, is given in the table below.

	£0	**£50 000**	**£100 000**	**£150 000**	**£200 000**	**£250 000**
Scheme 1	0	60	120	180	240	300
Scheme 2	0	65	125	190	235	280
Scheme 3	0	55	110	170	230	300

Minty wishes to maximise the net income. She decides to use dynamic programming to determine the optimal allocation, and starts the table shown in your answer book.

(a) Complete the table in the answer book to determine the amount Minty should allocate to each scheme in order to maximise the income. State the maximum income and the amount that should be allocated to each scheme.

(10)

(b) For this problem give the meaning of the table headings

(i) Stage,

(ii) State,

(iii) Action.

(3)

(Total 13 marks)

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8. Laura (L) and Sam (S) play a two-person zero-sum game which is represented by the following pay-off matrix for Laura.

	S plays 1	S plays 2	S plays 3
L plays 1	–2	8	–1
L plays 2	7	4	–3
L plays 3	1	–5	4

Formulate the game as a linear programming problem for Laura, writing the constraints as inequalities. Define your variables clearly.

(Total 7 marks)

TOTAL FOR PAPER: 75 MARKS

END

Centre No.						Paper Reference							Surname	Initial(s)
Candidate No.						6	6	9	0	/	0	1	Signature	

Paper Reference(s)

6690/01

Edexcel GCE

Decision Mathematics D2

Advanced/Advanced Subsidiary

Monday 1 June 2009 – Morning

Answer Book

Do not return the question paper with the answer book.

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
5	
6	
7	
8	
Total	

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1. (a) _____

_____

_____

(b)

	1	2	3	4
Jess	15	11	14	12
Matt	13	8	17	13
Rachel	14	9	13	15
Dummy				

Table 1

(c) *You may not need to use all of these tables*

	1	2	3	4
J				
M				
R				
D				

	1	2	3	4
J				
M				
R				
D				

	1	2	3	4
J				
M				
R				
D				

Leave blank

(Question 1 continued)

	1	2	3	4
J				
M				
R				
D				

	1	2	3	4
J				
M				
R				
D				

	1	2	3	4
J				
M				
R				
D				

	1	2	3	4
J				
M				
R				
D				

Allocation Jess does _____

Matt does _____

Rachel does _____

(d) Minimum cost: _____

Q1

(Total 9 marks)

Leave blank

2. (a)

	A	B	C	D	E	F
A	-	77	34	56	67	21
B	77	-	58	58	36	74
C	34	58	-	73	70	42
D	56	58	73	-	68	38
E	67	36	70	68	-	71
F	21	74	42	38	71	-

Leave blank

(Question 2 continued)

	A	B	C	D	E	F
A	-	77	34	56	67	21
B	77	-	58	58	36	74
C	34	58	-	73	70	42
D	56	58	73	-	68	38
E	67	36	70	68	-	71
F	21	74	42	38	71	-

Q2

(Total 12 marks)

Leave blank

3.

	B plays 1	B plays 2	B plays 3
A plays 1	–5	6	–3
A plays 2	1	–4	13
A plays 3	–2	3	–1

Leave blank

(Question 3 continued)

Q3

(Total 13 marks)

Leave blank

4. (a)

Value of cut C_1:

Value of cut C_2:

(b)

Q4

(Total 5 marks)

Leave blank

5. (a) x = _____

y = _____

z = _____

(b) _____

_____

_____

Q5

(Total 4 marks)

Leave blank

6. (a) _____

_____

_____

(b)

	A	B	C
X			
Y			
Z			

You may not need to use all of these tables

	A	B	C
X			
Y			
Z			

	A	B	C
X			
Y			
Z			

	A	B	C
X			
Y			
Z			

	A	B	C
X			
Y			
Z			

Leave blank

(Question 6 continued)

	A	B	C
X			
Y			
Z			

	A	B	C
X			
Y			
Z			

	A	B	C
X			
Y			
Z			

	A	B	C
X			
Y			
Z			

	A	B	C
X			
Y			
Z			

	A	B	C
X			
Y			
Z			

Q6

(Total 12 marks)

Leave blank

7. (a)

Stage	State (in £1000s)	Action (in £1000s)	Destination (in £1000s)	Value (in £1000s)
1	250	250	0	300 *
	200	200	0	240 *
	150	150	0	180 *
	100	100	0	120 *
	50	50	0	60 *
	0	0	0	0 *
2	250	250	0	280 + 0 = 280
		200	50	235 + 60 = 295
		150	100	
		100	150	
		50	200	
		0	250	
	200	200	0	
		150	50	
		100		
		50		
		0		
	150	150		
		100		
		50		
		0		
	100			

Leave blank

(Question 7 continued)

Stage	State (in £1000s)	Action (in £1000s)	Destination (in £1000s)	Value (in £1000s)

Maximum income: _____

Scheme	1	2	3
Amount to be invested (in £1000s)			

(b) _____

Q7

(Total 13 marks)

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8.

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(Question 8 continued)

Q8

(Total 7 marks)

TOTAL FOR PAPER: 75 MARKS

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